Sept. 18, 1951 H. HARTMANN 2,568,003

SWITCH CHOKE COIL

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Fig. 1.

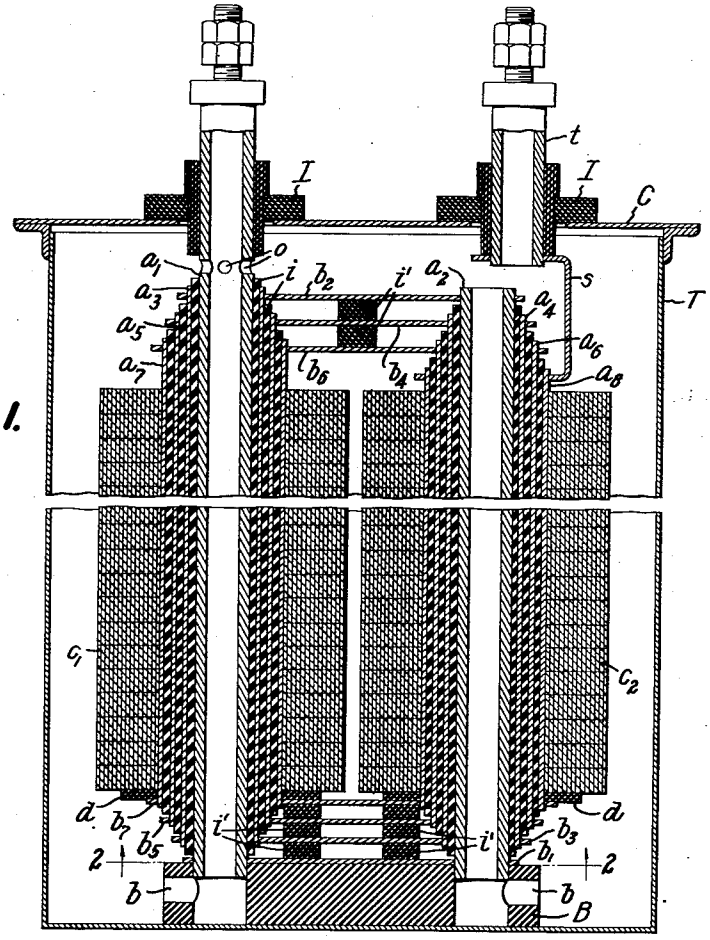
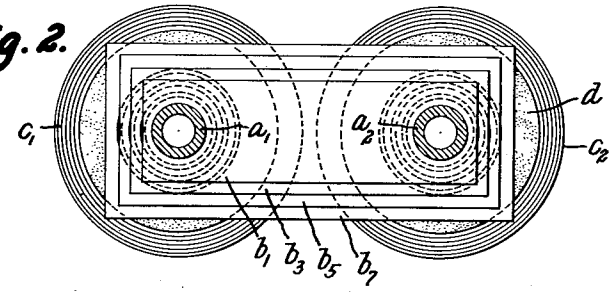


Fig. 2.



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SWITCH CHOKE COIL

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6 Claims. (Cl. 175—356)

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This invention relates to so-called switch choke coils employed in high voltage converters and inverters of the mechanical switching type.

The purpose of a switch choke coil is to widen out or prolong the period during which the current through the switch contacts is approximately zero, i. e. to produce a weak current interval of a given time duration, *dt*, for spark-free opening of the contacts of a mechanical switch at the end of the current-carrying period of the contacts. An equation for computing the weak current time interval *dt* is:

$$z.F=\frac{\sqrt{2}.10^8.U.dt}{dB}$$

where *z* is the number of turns of the choke coil windings; F is the cross-section of the active iron of the core; U is the direct current voltage; and *d*B is the changes in induction available according to the magnetization curve.

Good design practice for the iron requires that the iron core of the choke coils be wound as an annular core. The practice has been to form the high voltage winding in a plurality of sections connected in parallel and each suitably dimensioned to carry a part of the choke coil current. The conductor sections were wound by hand on the annular core in the form of disk coils, and this process was exceedingly time-consuming. In view of the necessity of subdividing the winding and the difficulty of winding the coil sections, a relatively large space was necessarily provided inside the core. The prior practice therefore yielded a poor factor of filling the core opening, and resulted in a large mass of material of poor magnetic characteristics. The relatively great width of the disk coils moreover led to undesired air fields which detrimentally affected the operation of the choke coils.

An object of the invention is to provide switch choke coils for high voltage converter and inverter systems, the windings and cores being of novel design and arrangement to afford compact and highly efficient constructions. More specifically, an object is to provide switch choke coils in which the winding consists of tubular conductors in coaxial telescoped arrangement, and the annular iron core is wound upon and carried by the outer conductor.

These and other objects and the advantages of the invention will be apparent from the following specification when taken with the accompanying drawing in which:

Fig. 1 is a fragmentary longitudinal section through a choke coil embodying the invention; and

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Fig. 2 is a transverse section on line 2—2 of Fig. 1.

In the drawing, the reference characters a_1 to a_8 identify a plurality of tubular conductors arranged in two groups of coaxially telescoped conductors, the axes of the two groups being in parallel physical relation and the conductors of the respective groups being electrically connected to each other in alternation by conductor straps b_1 to b_7 to form the single series-circuit winding of the choke coil. Sleeves or strips *i* of insulation are arranged between the telescoped conductors of each group to provide a rigid mechanical assembly of the several parts of the winding.

The innermost conductor a_1 of one group and the outermost conductor a_8 of the other group serve as the terminals of the winding. The conductor a_1 is preferably extended through an insulator I carried by the cover C of a tank T, for connection into the external circuit network, but the outer conductor a_8 can not be similarly extended in view of the conductor straps b_2, b_4 and b_6. A part of the conductor a_8 could be cut away to clear the conductor straps but preferably, as shown, the connection to the exterior of the tank T is by way of a connecting strap *s* and a terminal rod or tube *t* supported in a second insulator bushing I.

The conductors of each group are preferably stepped or varied in length in order that the connecting straps b_1 to b_7 may be parallel to each other. Connector b_1 joins the lower ends of conductors a_1 and a_2, and connector b_2 connects the upper ends of conductors a_2 and a_3. In like manner, the remaining connectors are applied to connect the several tubular conductors in series.

Annular cores c_1 and c_2 are wound directly upon the outer tubular conductors a_7 and a_8 of the two groups, and the cores assume the potential of the portions of the conductors to which they are applied. Each core may consist of a single sheet of soft iron but preferably, as illustrated, the cores are formed as a plurality of windings of iron bands of relatively small axial length. The total axial length or height of a core is approximately equal to the length of the conductor upon which it is wound. Disks *d* of insulating material are arranged between the lower ends of the cores c_1, c_2 and the adjacent connecting straps b_7, and strips *i'* of insulation are preferably arranged transversely between adjacent pairs of connecting straps to space and strengthen the same. The connecting straps may

be of any desired type and, as illustrated, are in the form of rectangular plates with spaced circular openings into which the ends of a pair of tubular conductors are snugly fitted and soldered or welded.

The lower ends of the innermost conductors a_1 and a_2 extend into cylindrical openings in a block B of insulation by which the assembly is supported on the bottom wall of the tank T, and the lowermost connecting strap or plate b_1 rests upon the top of the block. Bores b at the ends of the supporting block communicate with the cylindrical openings into which conductors a_1, a_2 are stepped to permit a circulation of the insulating oil through the tubular conductors for cooling. The upper end of the conductor a_1 is provided with transverse openings o to permit this oil circulation when, as illustrated, the conductor a_1 extends to the exterior of the tank T.

The number of concentric tubes of each of the parallel groups is in general equal to the number of turns of the choke coil winding as this condition locates the winding terminals on different groups.

The described construction has numerous advantages over the prior switch choke coils. The annular cores are wound directly upon the outermost conductors and this construction is particularly favorable with respect to the quantity of material required and to the magnetic characteristics of the assembly. An exceedingly satisfactory filling factor of the core opening is thus assured with minimum core dimensions. The optimum utilization of the core opening results in a maximum cross-sectional area F of the core with a minimum mass or weight of the core. There are no air paths for the magnetic flux in parallel with the iron path since the iron core closely encloses the winding, and the space between the parallel groups of coaxially telescoped conductors can be filled practically completely by iron, thereby substantially completely excluding an air path for the flux. Furthermore, the eddy current losses are reduced to a minimum by the conductor arrangement.

The tank T is filled with an insulating oil, not shown, according to current practice, and the insulation i between telescoped conductors may provide longitudinal passages for thermosyphonic cooling of the choke coil.

It is to be understood that the invention is not limited to the particular constructions herein shown and described since variations which may occur to those familiar with the art

fall within the spirit and scope of the invention as set forth in the following claims.

I claim:

1. In a choke coil for use with high current rectifiers and inverters with mechanical switching and of the type comprising a multi-turn winding threaded through a ring-form iron core; two groups of coaxially telescoped conductors in parallel physical relation, conductor straps connecting the conductors of the respective groups together in alternation to form a single series-circuit winding, and an annular iron core surrounding the outermost conductor of each group.

2. In a choke coil, the invention as recited in claim 1, wherein each core comprises a spiral winding wound directly upon and in electrical contact with the associated conductor.

3. In a choke coil, the invention as recited in claim 1, wherein the conductors of each group are stepped as to length, and said conductor straps are in parallel physical relation to each other.

4. In a choke coil, the invention as recited in claim 1, wherein the axial length of an annular core is approximately equal to the length of the outermost conductor which it surrounds.

5. In a choke coil, the invention as recited in claim 1, wherein each annular core comprises a plurality of axially superposed windings of bands each of relatively short axial length.

6. In a choke coil, the invention as recited in claim 5, wherein each of said core bands is wound directly upon and in electrical contact with the outermost conductor which it surrounds.

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